

LASE measurements of precipitable water vapor and aerosol extinction profiles during GRIP

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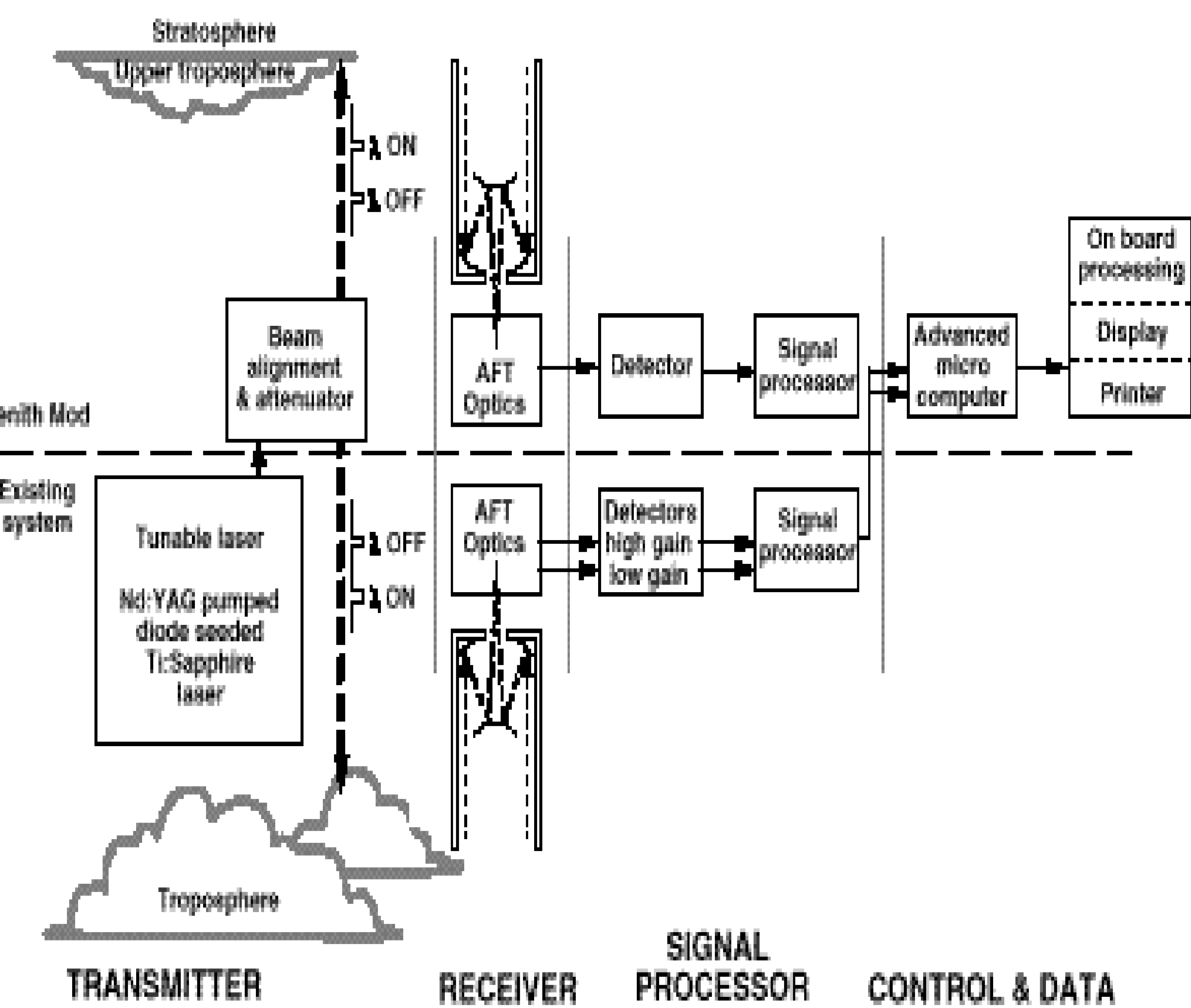
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LASE (Lidar Atmospheric Sensing Experiment) system and the data products



System Features:

- DIAL system operating in the 817nm band of H₂O
- Uses a Ti: sapphire laser (100 mJ at 5 Hz double pulsed)
- 3 line pairs are used to capture the full dynamic range of water vapor in the troposphere

Data Products:

- **Water vapor mixing ratio profiles**
 - surface to upper troposphere
 - 0.01 to 25 g/kg
 - accuracy: 6% or 0.01 g/kg
 - resolution (variable)
 - vertical: 300 m nadir, 990 m zenith
 - horizontal: 42 to 70 km (3 – 5 min)
- **Aerosol/cloud profiles**
 - daytime and nighttime
 - 0.03 to 25 km
 - resolution (nominal)
 - vertical: 30 m
 - horizontal: 2.1 km

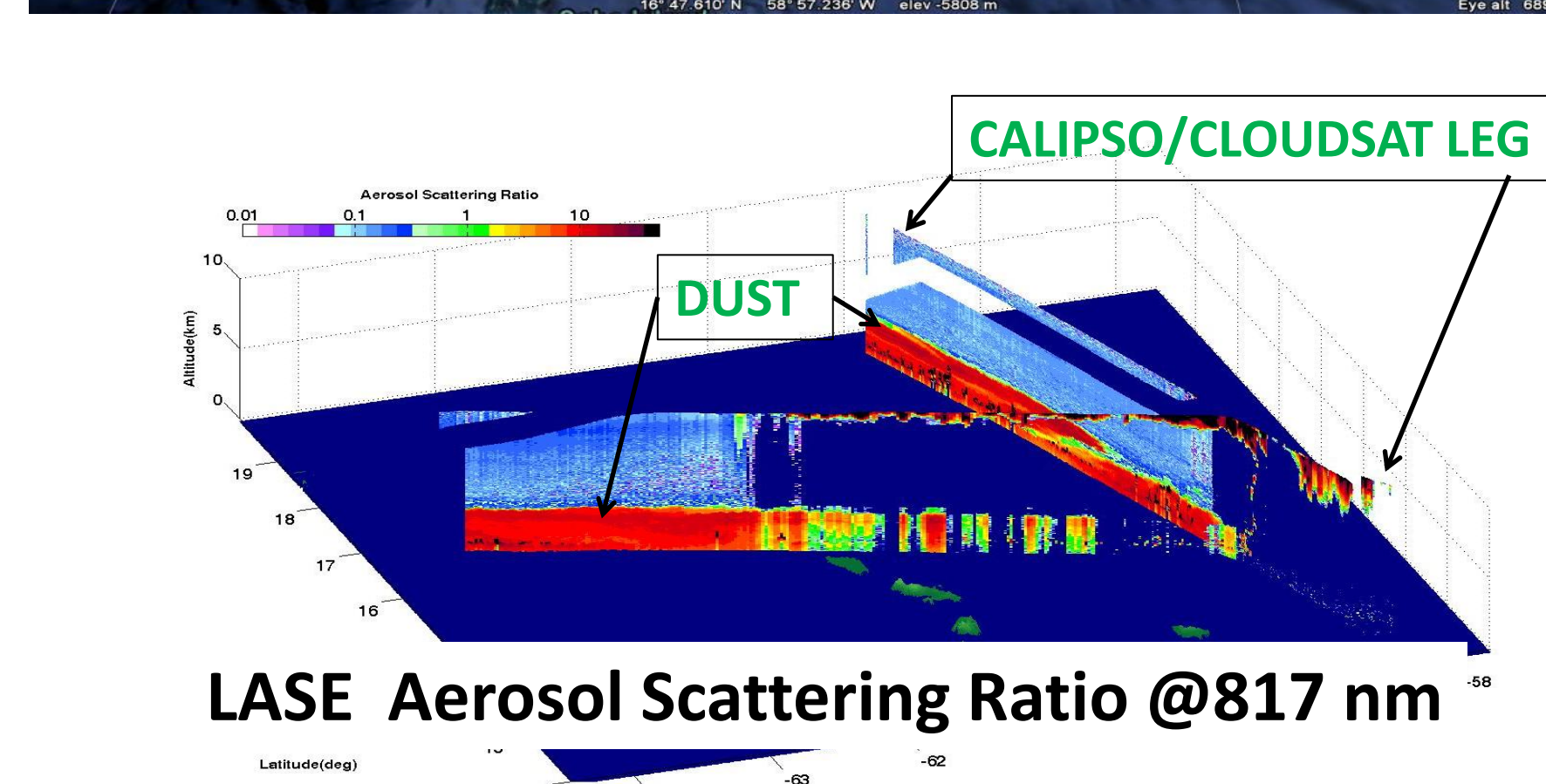
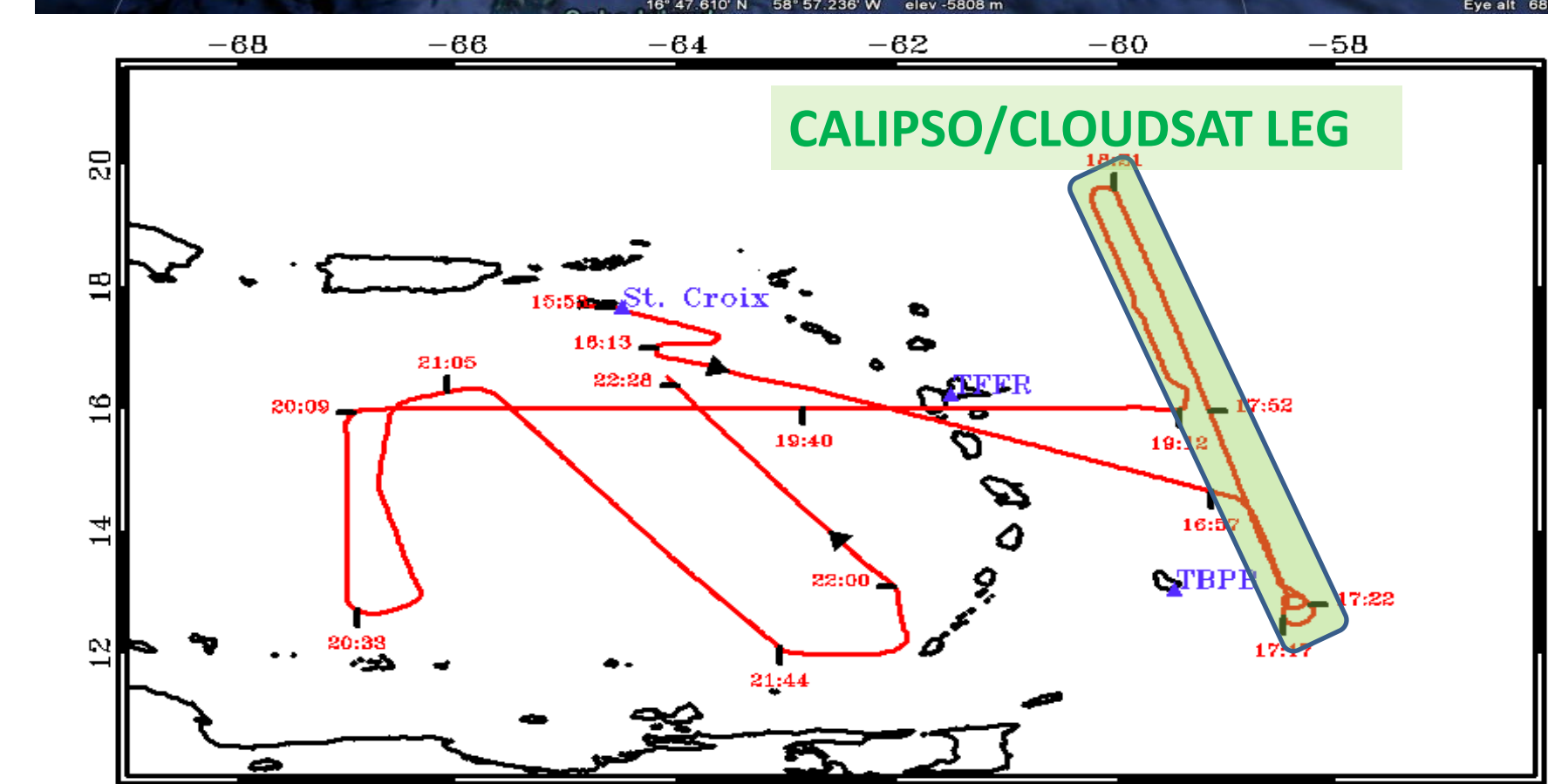
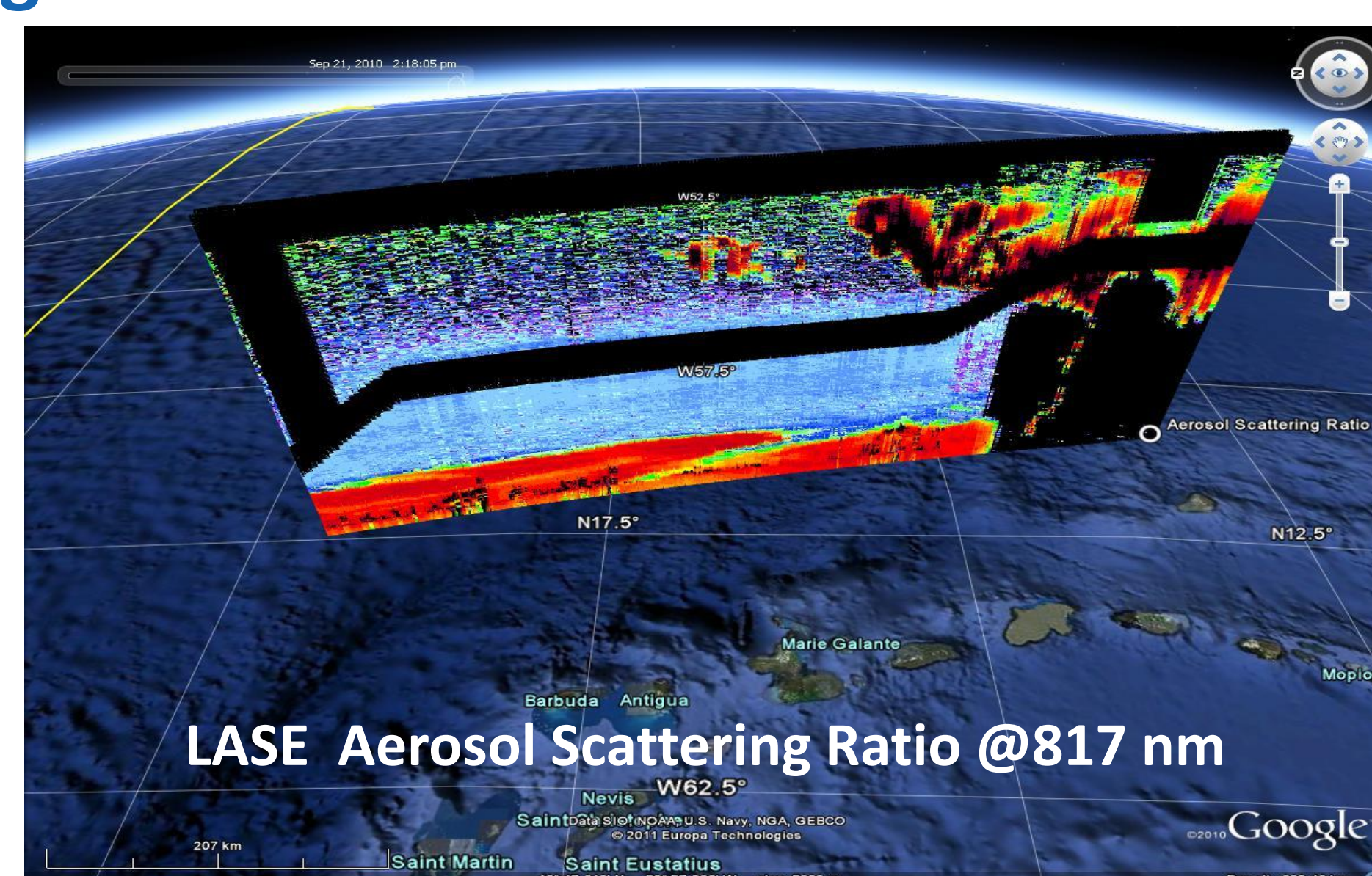
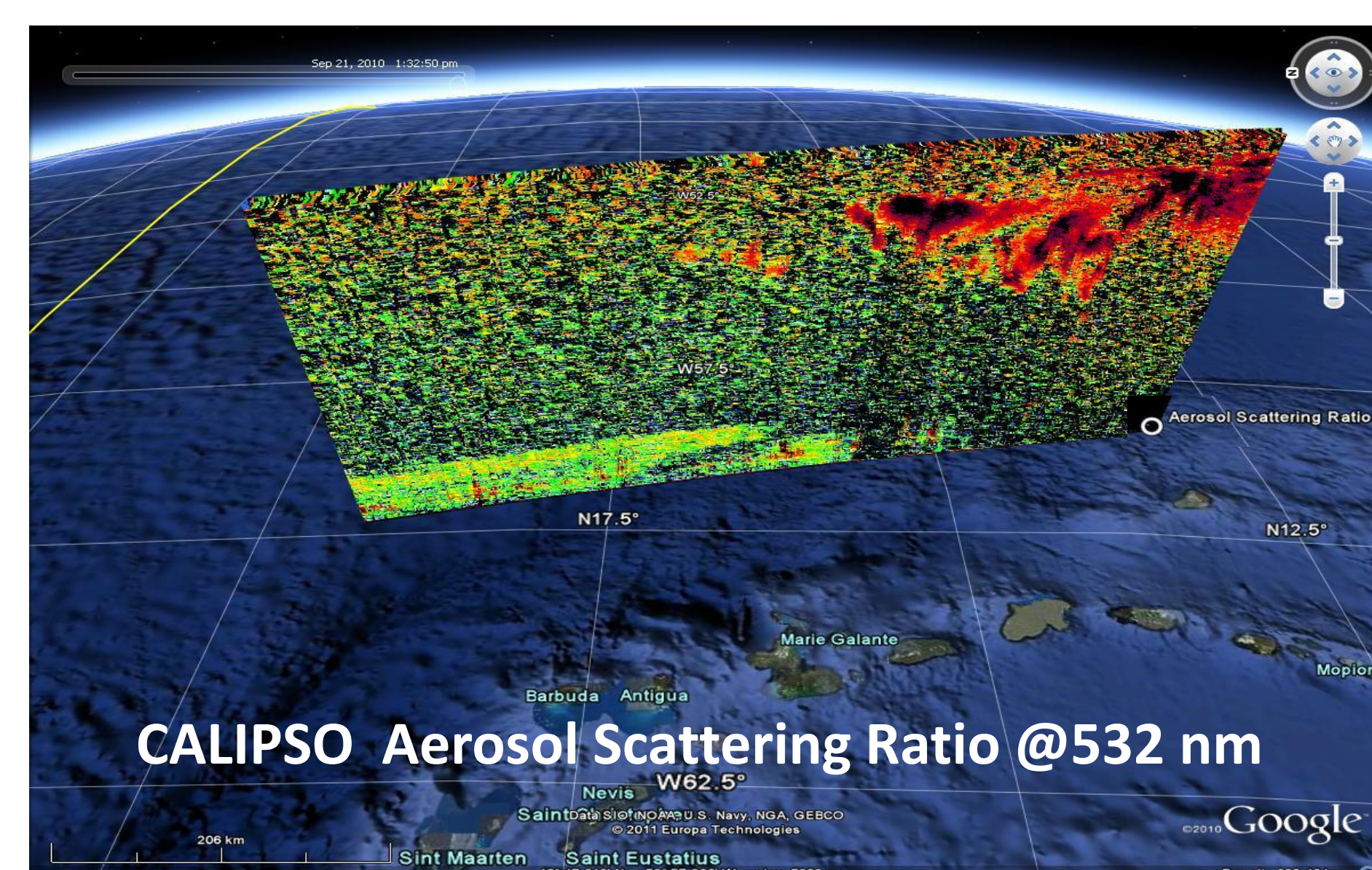
Advanced Data Products:*

- RH derived from LASE mixing ratio and dropsonde/radiosondes, Total Precipitable Water (TPW), aerosol extinction and scattering coefficient profiles, and aerosol optical depth
- *Retrieved on a case by case basis on request

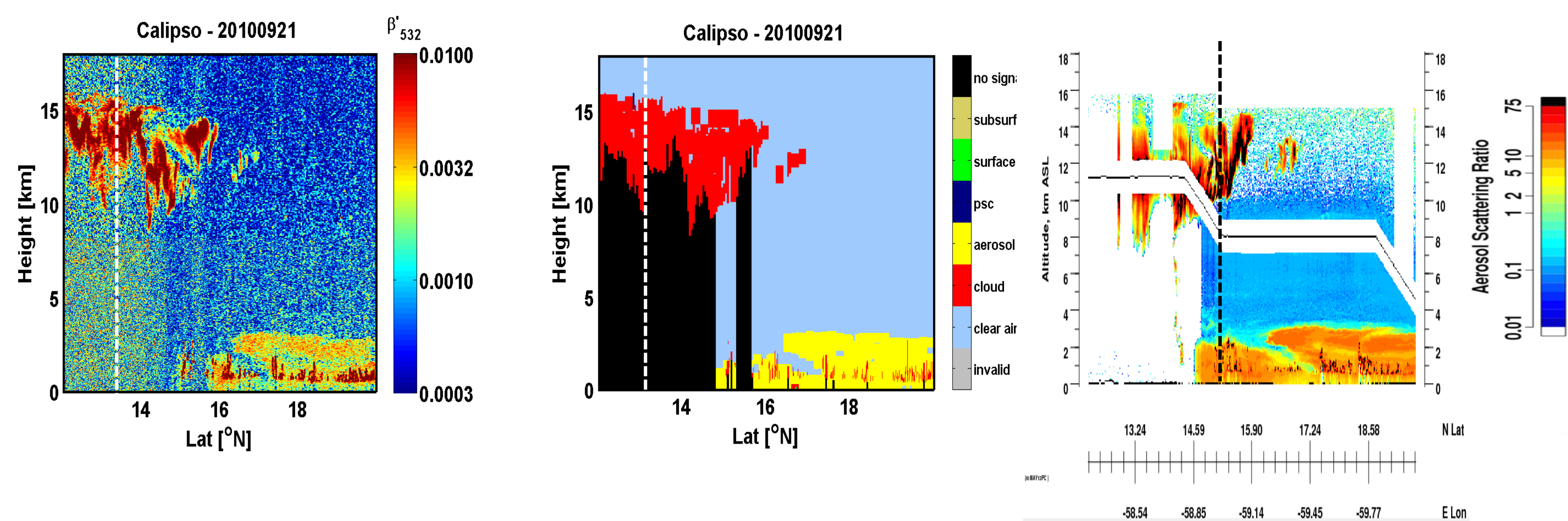
Case Study:

Flight 23 / PGI-46 / September 21, 2010 CALIPSO & CLOUDSAT underpass

Aerosol Scattering Ratio: CALIPSO



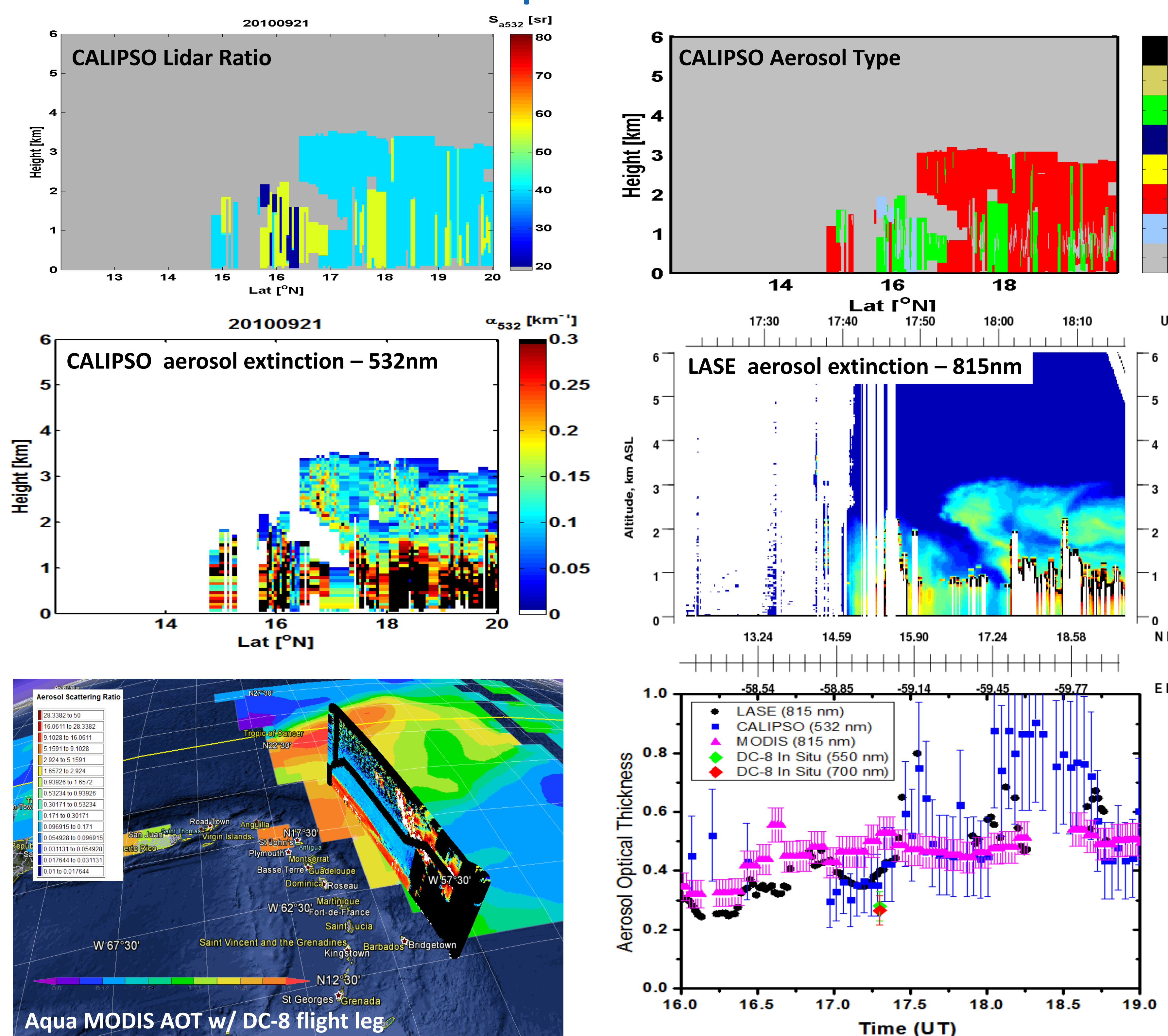
During the GRIP flight 23 on September 21, the DC-8 flew along a CALIPSO/CloudSat ground track and within the swath of MODIS on Aqua. LASE measurements between 17:20-18:22 UT are compared with CALIPSO measurements acquired at 17:30 UT along this same flight segment. The top panels show CALIPSO (left) and LASE (right) measurements of aerosol scattering ratio along this flight segment. The bottom left panel shows the DC8 flight track map with the CALIPSO ground track segment highlighted in green. The map in the lower right shows a portion of the LASE aerosol scattering ratio data during this flight. Note the presence of dust in this region.



These panels show a closer view of the CALIPSO attenuated backscatter (left), CALIPSO classification (middle), and LASE aerosol scattering ratio measurements along the CALIPSO/DC-8 segment. Note the good agreement in the location of the aerosol and cloud layers. The vertical dashed line indicates the location of actual temporal coincidence.

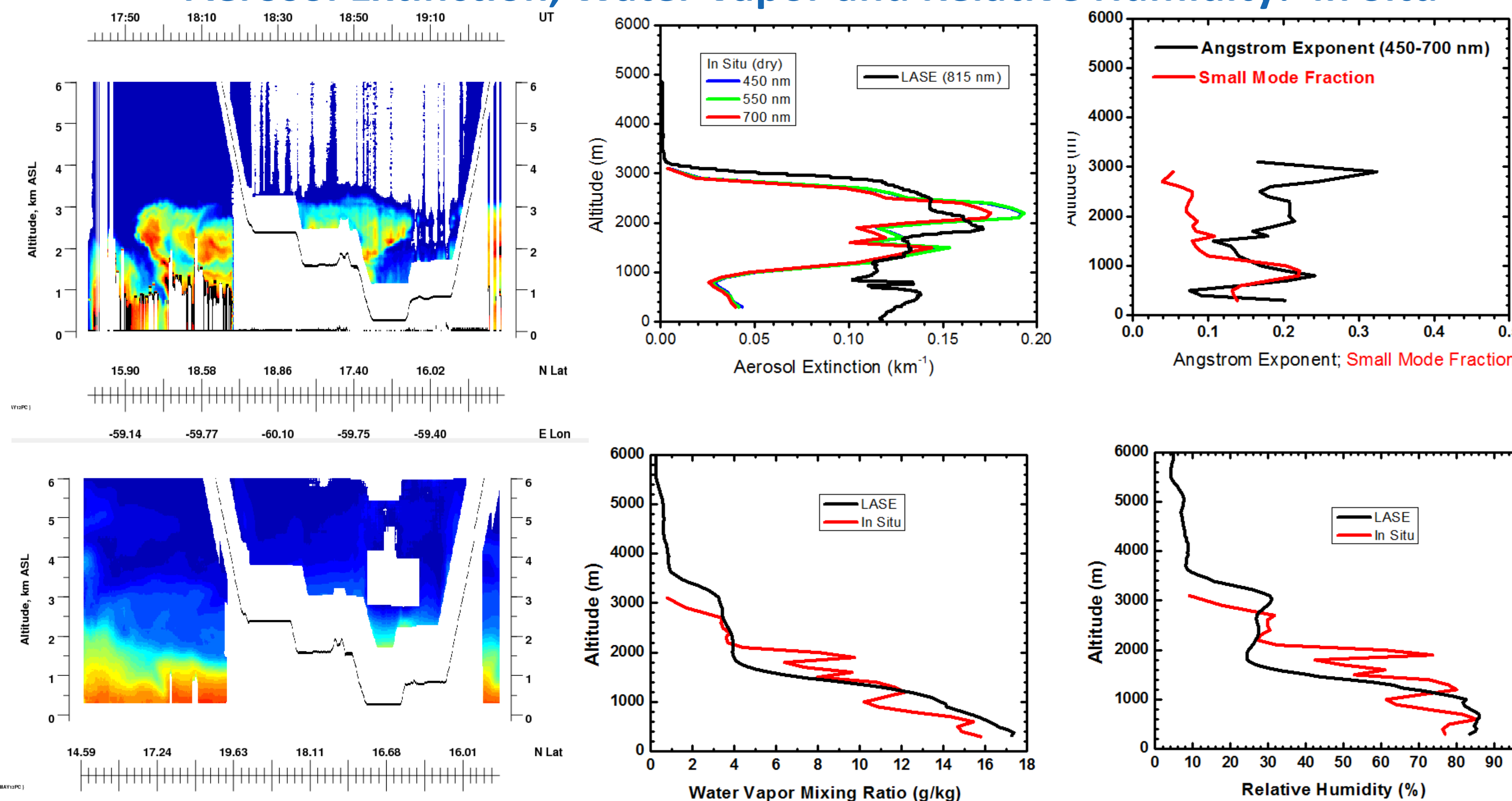
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Aerosol Extinction and Optical Thickness: MODIS & CALIPSO



Computation of aerosol extinction profiles from LASE requires an estimate of the aerosol extinction/backscatter ratio (e.g. "lidar ratio") or an additional constraint. Here we use Aqua MODIS AOT (shown in bottom left panel with DC-8 flight track overlaid) to constrain the LASE retrievals of aerosol extinction and to provide an estimate ($S_0 = 40$ sr) of the lidar ratio. This lidar ratio is consistent with the lidar ratio for dust found during the NAMMA campaign and is also consistent with that assumed for CALIPSO as shown by the top left and top right panels. Profiles of aerosol extinction from CALIPSO (532 nm) (middle left) and LASE (815 nm) (middle right) show generally good agreement in the dust layer above 1.5 km; below this altitude, cloud interference complicates direct comparisons. A comparison of aerosol optical thickness (bottom right) shows generally good agreement for the portion of the track from 16.5 to 17.5 UT that was least affected by low clouds.

Aerosol Extinction, Water Vapor and Relative Humidity: In Situ

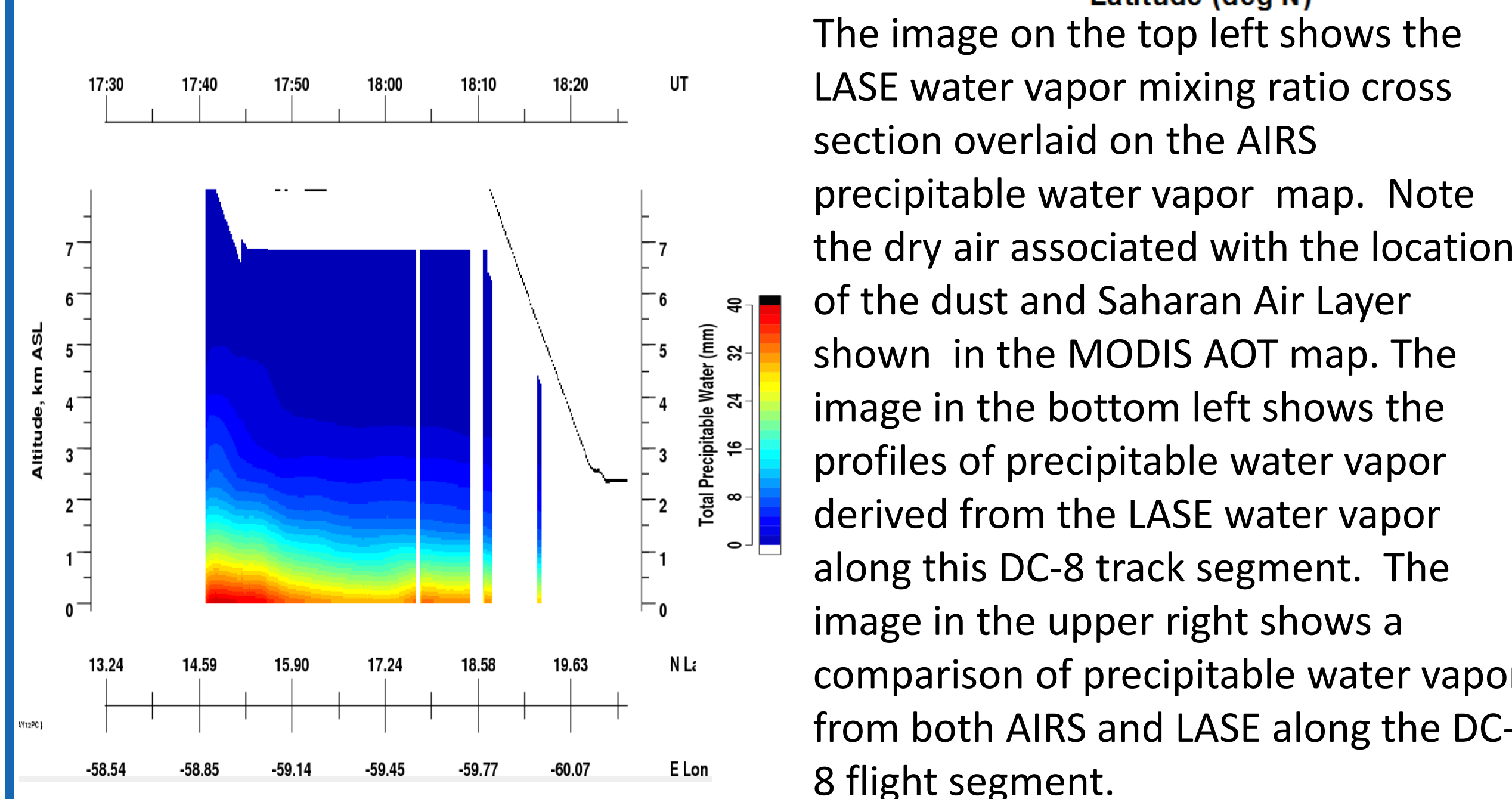
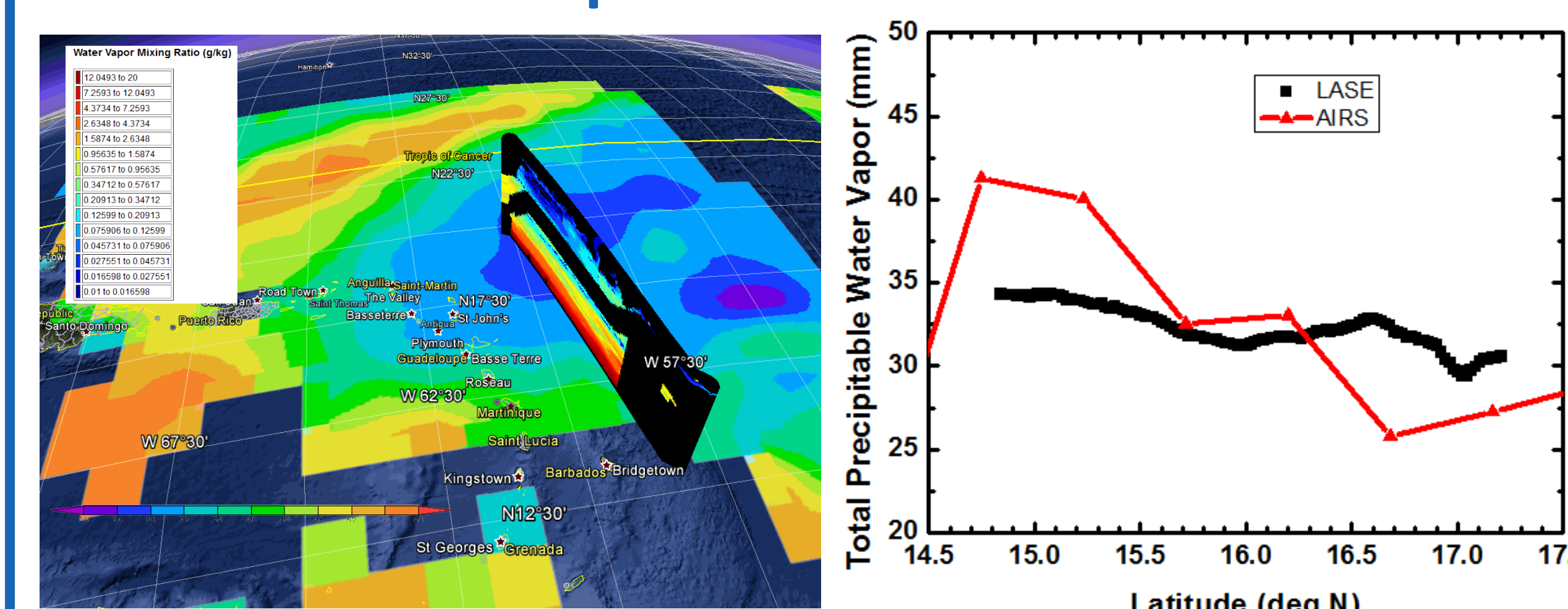


The in situ measurements on board the DC-8 were also used to examine this segment of data. Aerosol extinction profiles (top left) were generated from the DC-8 LARGE in situ measurements of aerosol dry scattering and absorption. These profiles are consistent with the LASE measurements of aerosol extinction in the dust layer above 1.5 km. Below this altitude the differences between the LASE and in situ measurements are likely due to cloud interference and the aerosol humidification not accounted for the in situ measurements. The top right panel shows that the aerosols are generally large (super micron) particles; most likely dust. The bottom panels show good agreement between the LASE and DC-8 in situ measurements of water vapor mixing ratio and relative humidity profiles.

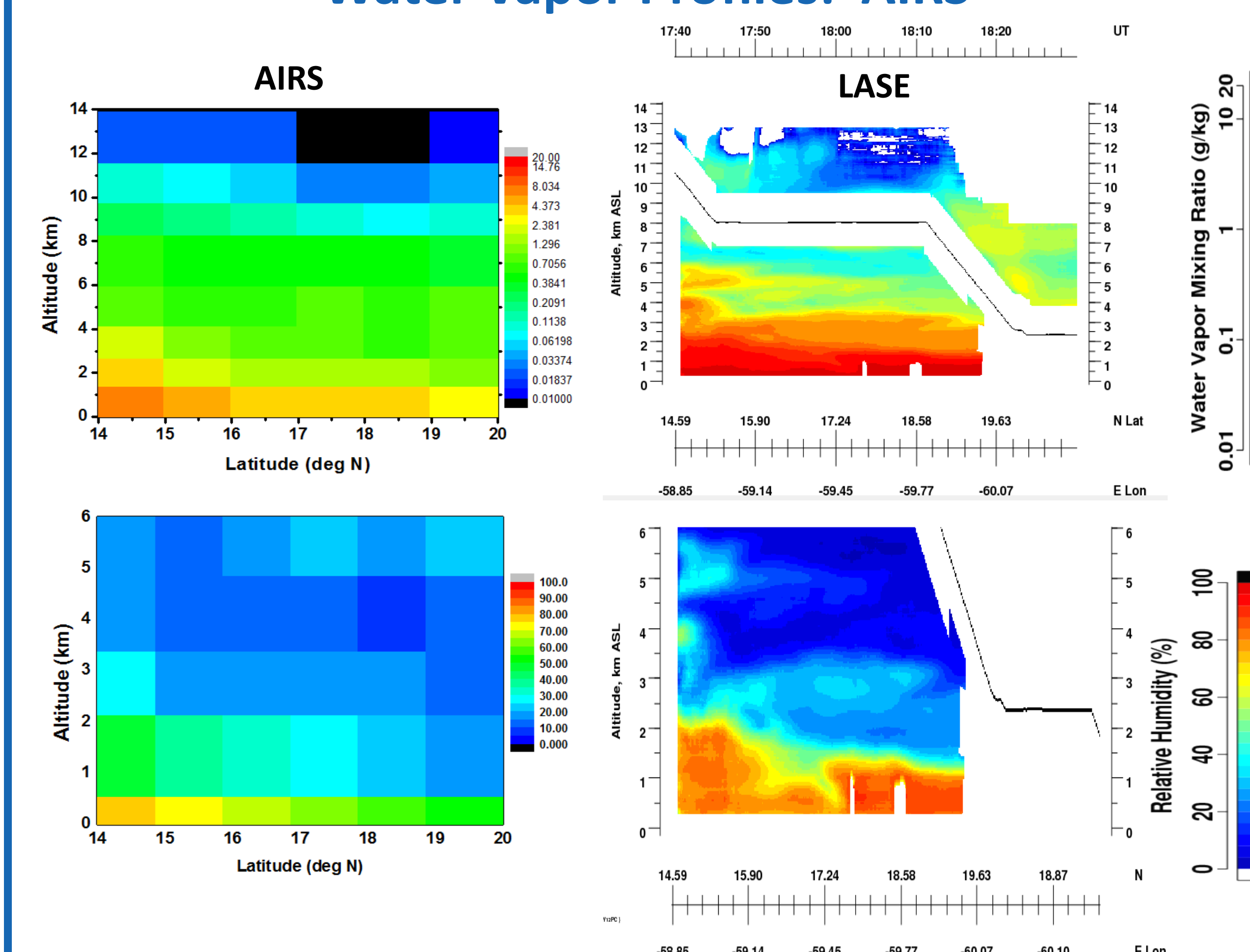
Summary

- LASE and satellite water vapor and aerosol measurements from September 21, 2010 are examined
- LASE measurements are used to derive aerosol optical thickness and profiles of aerosol extinction
- LASE, CALIPSO, and DC-8 in situ measurements of aerosol extinction profiles are in good agreement in the elevated Saharan dust layer observed east of the Lesser Antilles Islands
- LASE and AIRS precipitable water vapor measurements are in good agreement along this same flight segment
- LASE and satellite measurements show lower water vapor amounts associated with the high dust amounts seen in this Saharan Air Layer

Precipitable Water: AIRS



Water Vapor Profiles: AIRS



These images show AIRS (left) and LASE (right) cross sections of water vapor mixing ratio (top) and relative humidity (bottom) along the DC-8 CALIPSO/CloudSat flight segment.